Analytic Vs Numeric Ground Water Models

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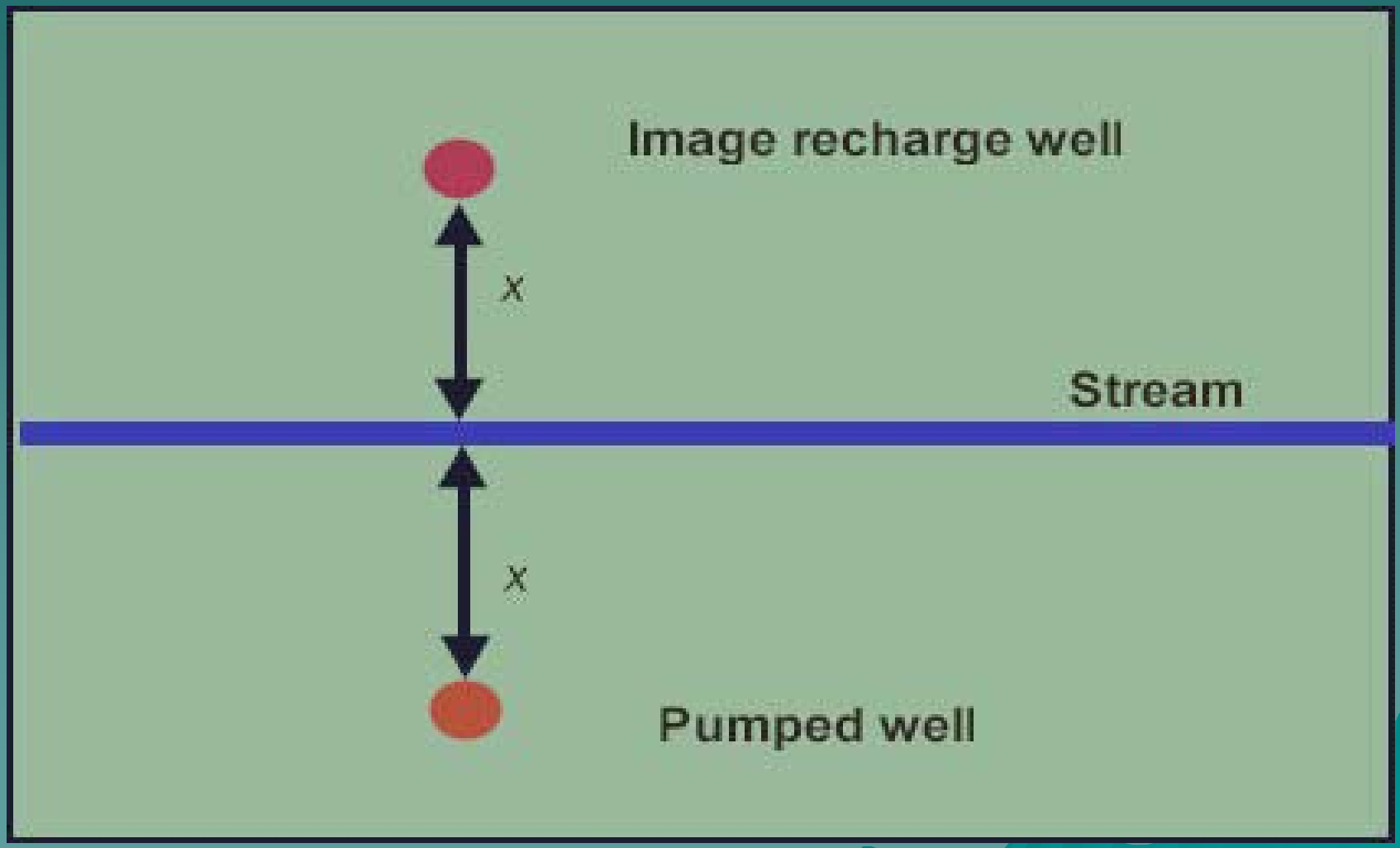
Colorado Division of Water Resources

Example Analytic (Glover) Application



Analytic (Glover)

- Depletion (q) is a function of:
  - Pumping (Q)
  - Transmissitivity (T)
  - Specific Yield (Sy)
  - Distance from well to river (x)
  - Distance to Aquifer Boundary (w)
- Data is assigned by Aquifer (1 value)
- RELATIVELY SIMPLE

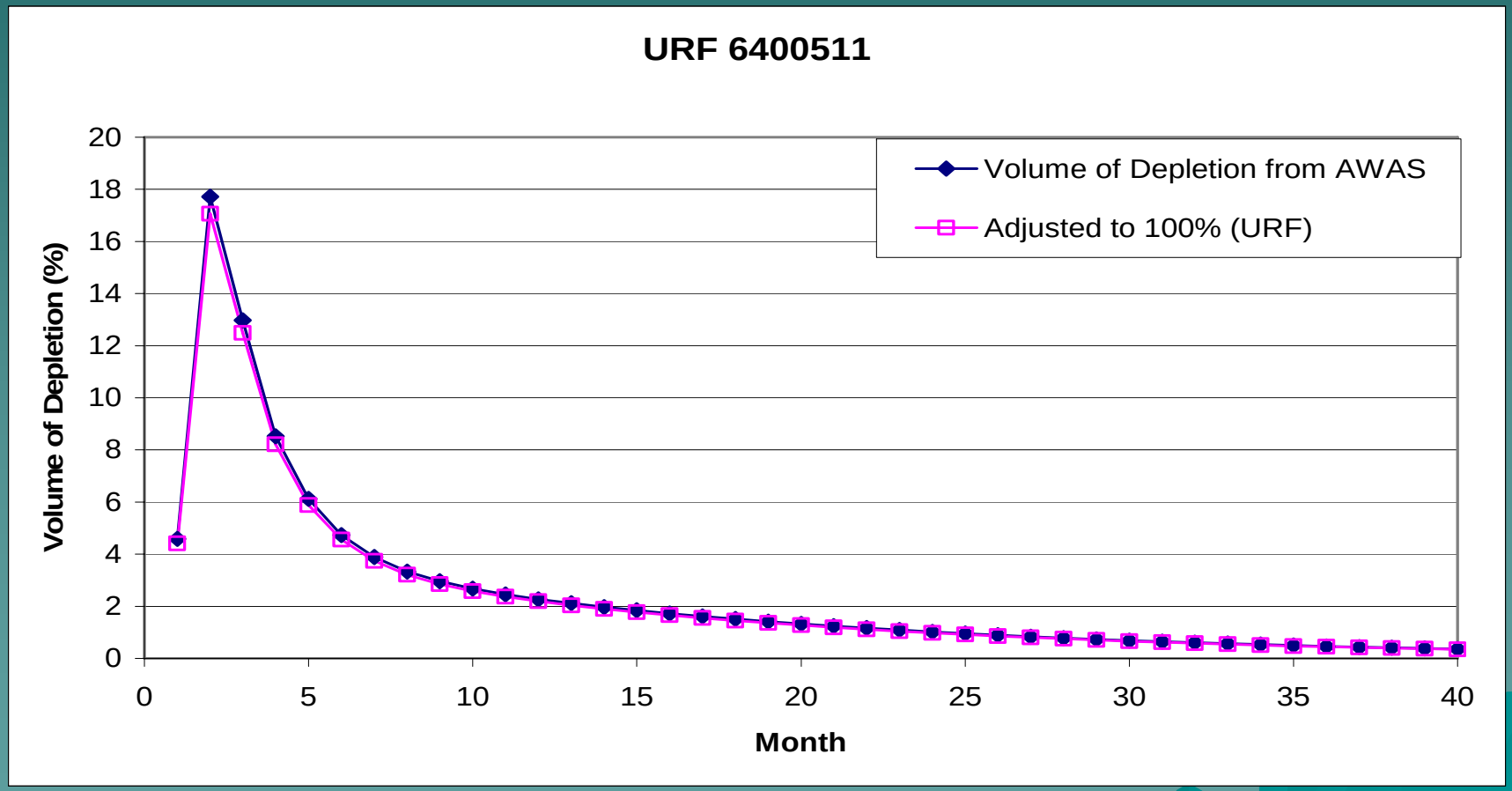
Analytical (Glover)

Key Assumptions

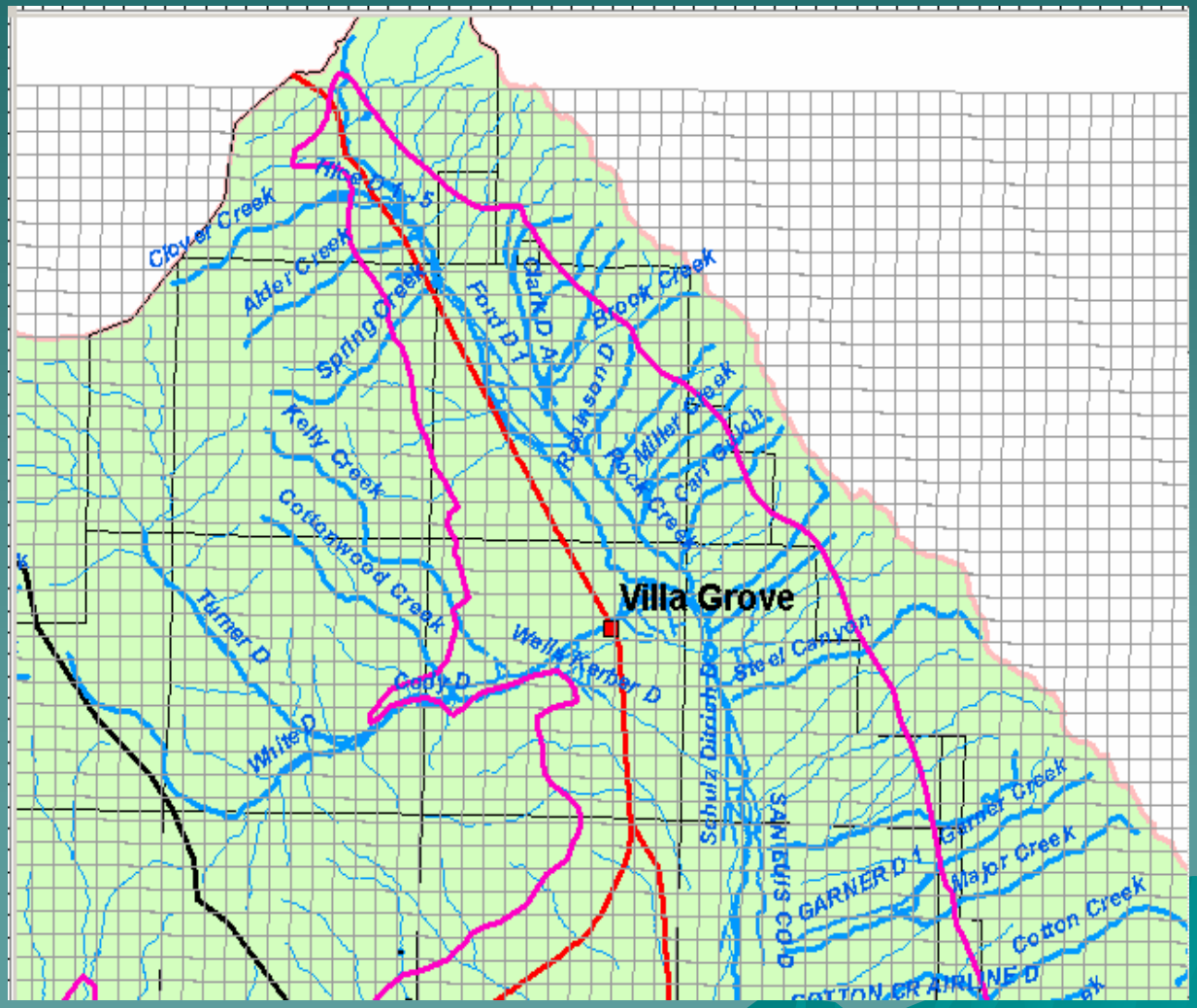
- Conductivity (K) is Constant
- Uniform Aquifer Thickness
  - Transmissitivity is Constant
- Flat Water Table
- Stream is Fully Penetrating

Analytical (Glover) Results

Response from Pumping in Month 1 Only



Example Numeric Model

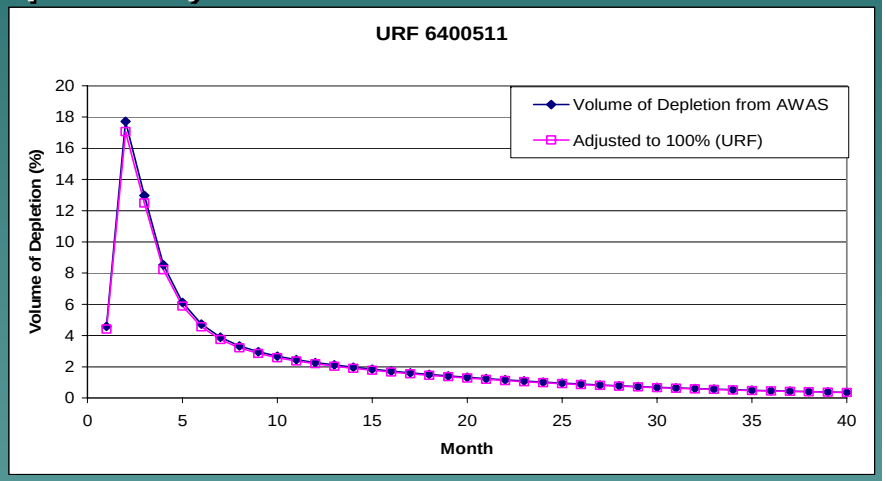


Numerical (Modflow) Model

- Depletion is still a function of:
  - Pumping (Q)
  - Hydraulic Conductivity (K)
  - Aquifer Thickness (b)
  - Specific Yield (Sy) or Storage Coefficient (S)
  - Distance from well to river (x)
  - Distance to Boundary (w)
- Data is assigned by Model Cell (1,000's)
- Might include complex geometry, multiple layers, boundary conditions, partially penetrating streams, ET from GW, subirrigation, impact on canals, ...
- LOTS of WORK

Numerical (Modflow) Results

- Stream Depletion
  - By stream Reach (not a point)
- Water Levels
- Ground Water Balance
- Stream Water Balance
  - Phreatophyte CU
  - Subirrigation
  - Complex Geology (faulting)
  - Complex Boundaries
  - Multiple, Layered Aquifers

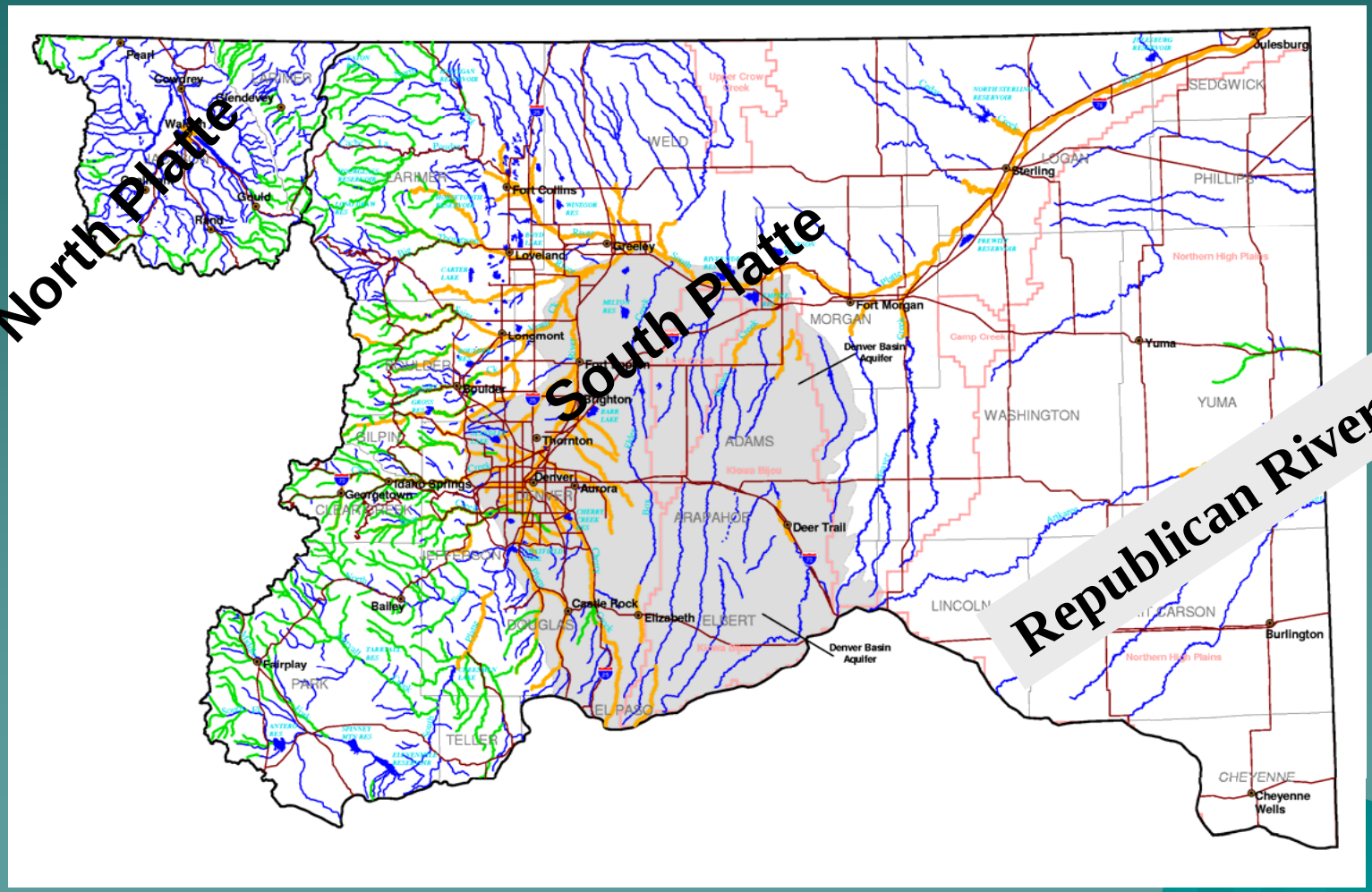


Comparison Summary

Item	Analytical	Numerical
Stream Depletion	Yes	Yes
Assumptions	High	Low-High
Water Levels	No	Yes
Complex Geology	No	Yes
Dry Stream	No	Yes
Multiple Aquifers	No	Yes
Effort	Low	Med-High

South Platte DSS

Division 1 except Republican (WD 65) and North Platte (WD 47)



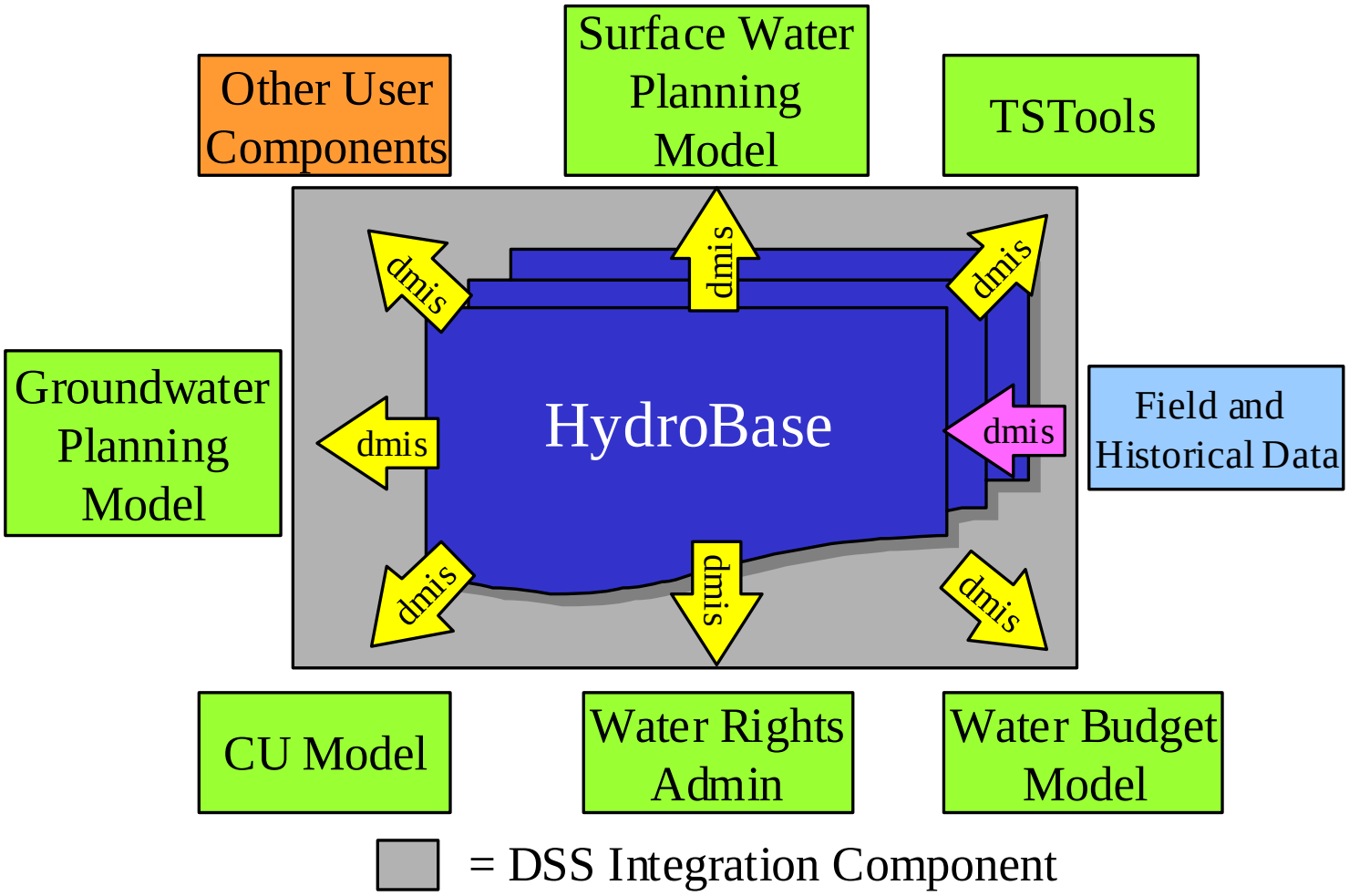
Colorado Water Conservation Board and Division of Water Resources

SPDSS

Major Components

- Data - Tabular and Maps
- New Data - Irrigated Lands, stream gages, aquifer data, and observation wells
- Tools – CU, SW, GW
- User Involvement
- Documentation & Product Distribution

DSS Components

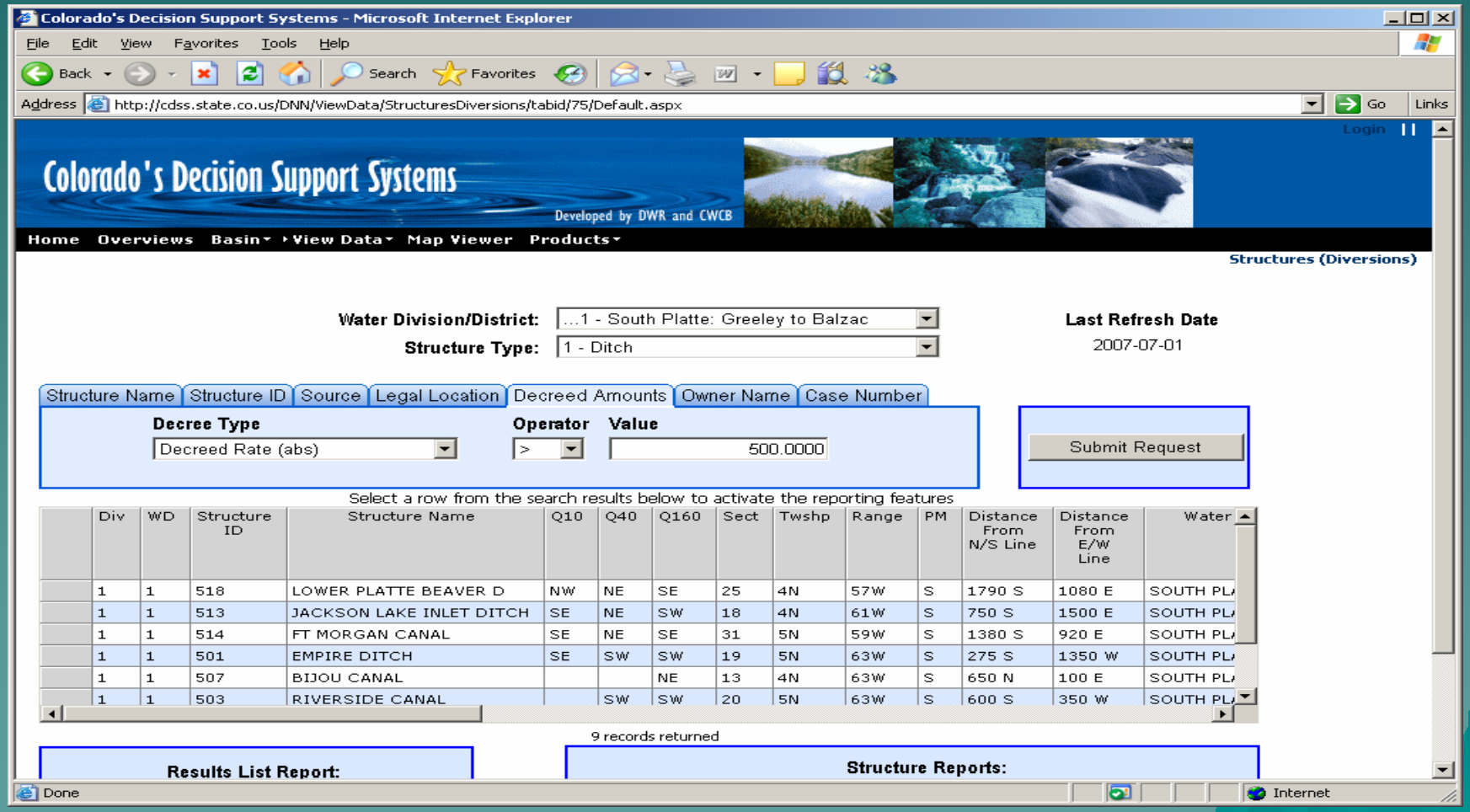


Tabular Data

- Stations
  - Streamflow
  - Climate (temp, ppt., evap.)
- Structures
  - Diversions
  - Reservoirs
  - Instream Flows
- Water Rights
  - Transaction
  - Net
- Ground Water
  - Water Levels
  - Pumping Tests
- Calls
  - Tributary
  - Mainstem
- Other
  - Agricultural Statistics
  - Crop Growth Coefficients

Tabular Data

Internet (WWW)

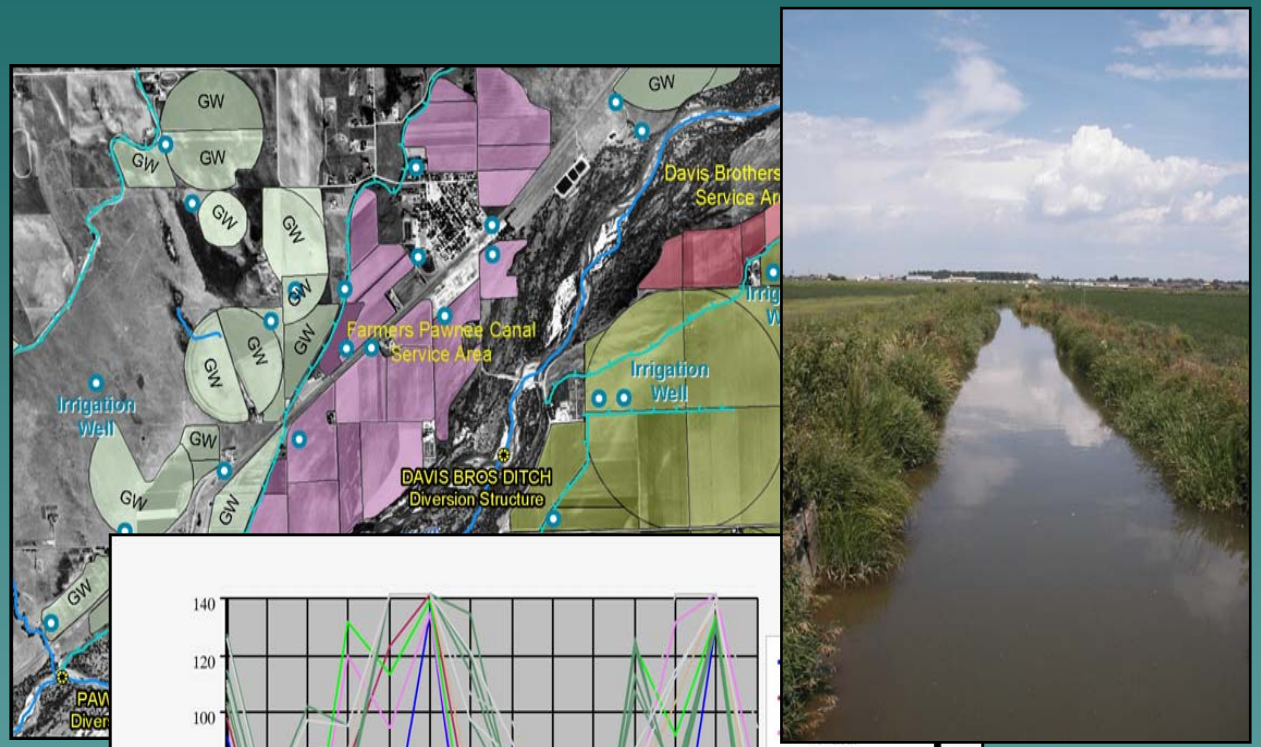


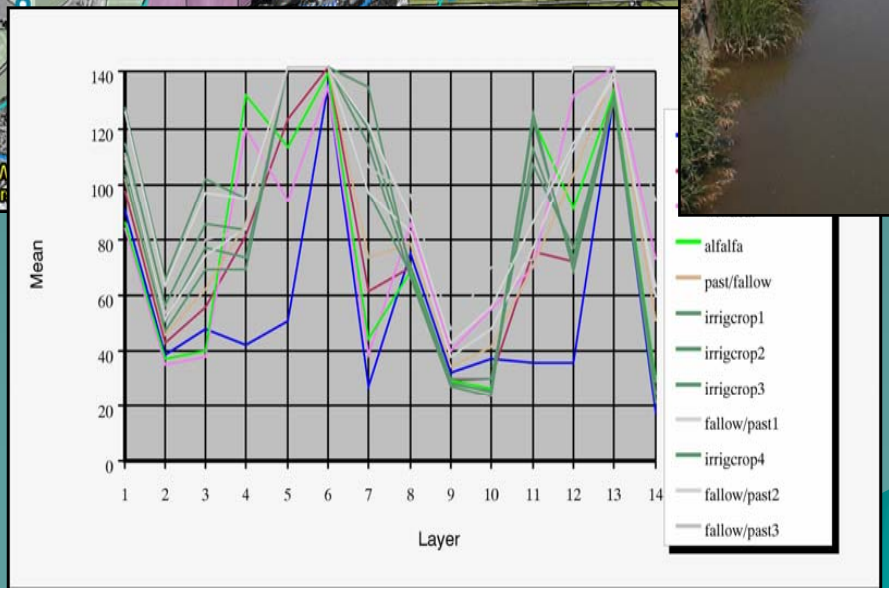
Spatial (Map) Data

- Basemap
  - Hydrology
  - Roads
  - Cities and Towns
  - Public Land Survey (T-R-S)
- Stations
  - Diversions
  - Reservoirs
  - Instream Flows
  - Climate
- Irrigated Acreage
  - Water Source
  - Crop Type
  - Irrigation Method
- Other
  - Average precipitation
  - Average evaporation
  - Canals
  - Drains

Spatial Data

Irrigated Acreage Mapping





Irrigated Area,

Crop Type,

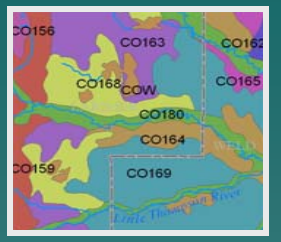
Irrigation Method,

Water Supply

Consumptive Use

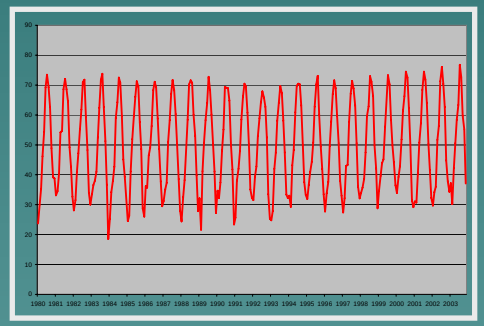
StateCU

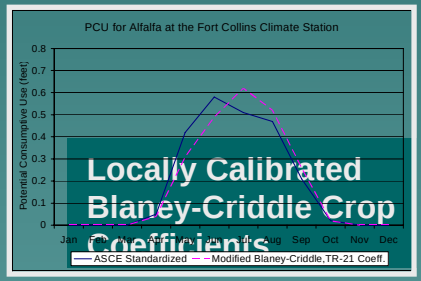
Irrigated Acreage and Crop Type



Soil Data

Climate Data





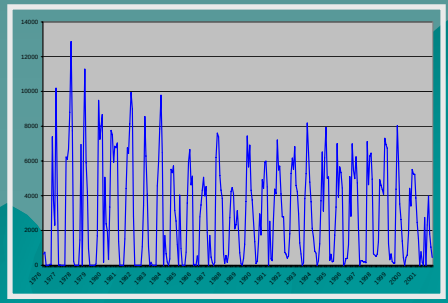
Locally Calibrated Blaney-Criddle Crop Coefficients

PARCEL	CROP_TYPE	IRRIGATION	ACREAGE	PERIMETER
10101	Alfalfa	Sprinkler	131.832	2610.943
10102	Corn	Flood	135.253	2650.783
10103	Alfalfa	Sprinkler	124.643	3103.069
10104	Corn	Sprinkler	123.794	2532.175
10105	Corn	Flood	133.197	2619.833
10106	Small Grains	Sprinkler	135.335	2649.933
10107	Alfalfa	Flood	134.877	2637.105
10108	Alfalfa	Flood	134.181	2637.852
10109	Small Grains	Flood	125.197	2542.805
10110	Alfalfa	Sprinkler	122.907	2521.061

Irrigation Method

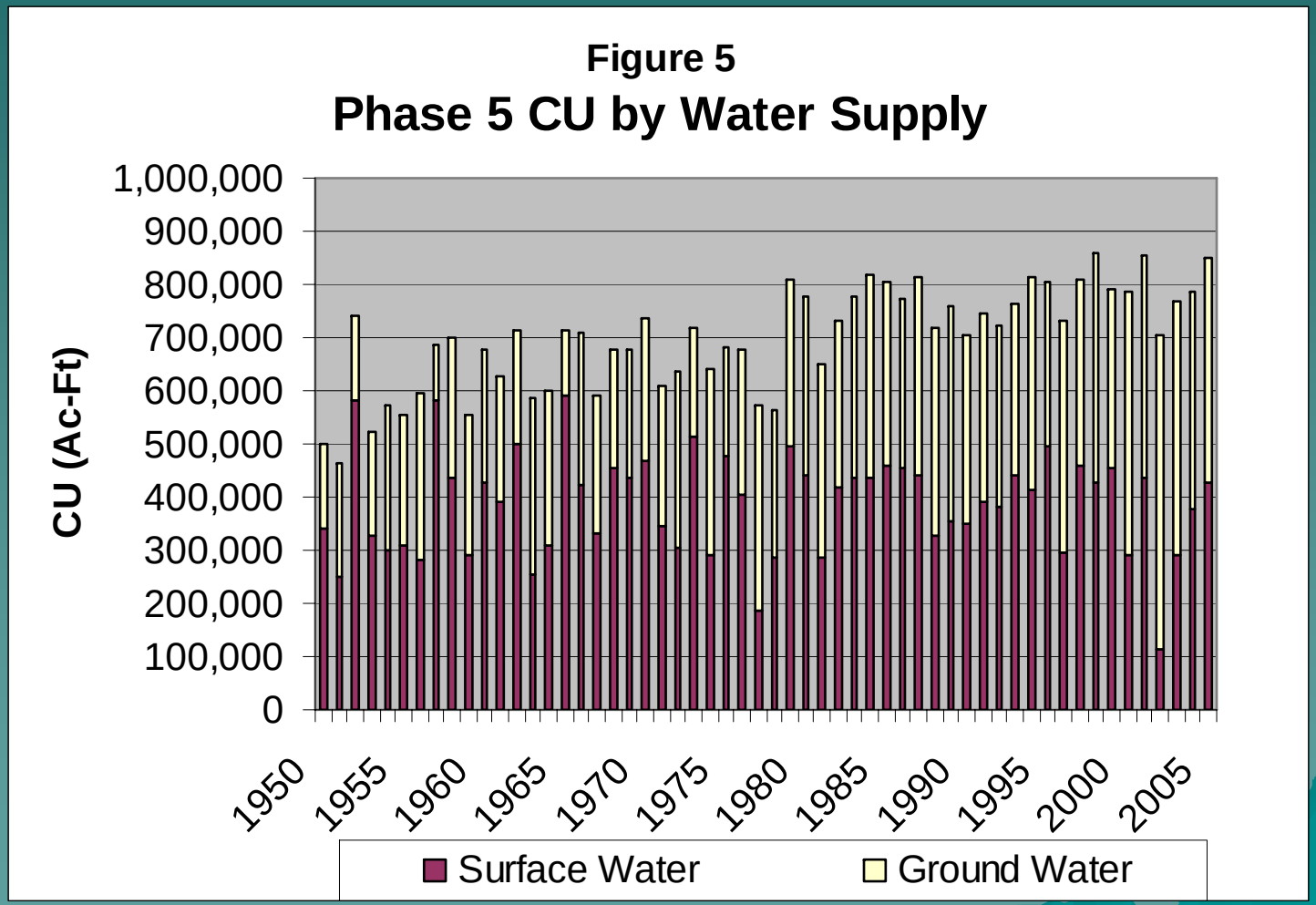
Ditch Efficiencies

Surface Water Supply Data

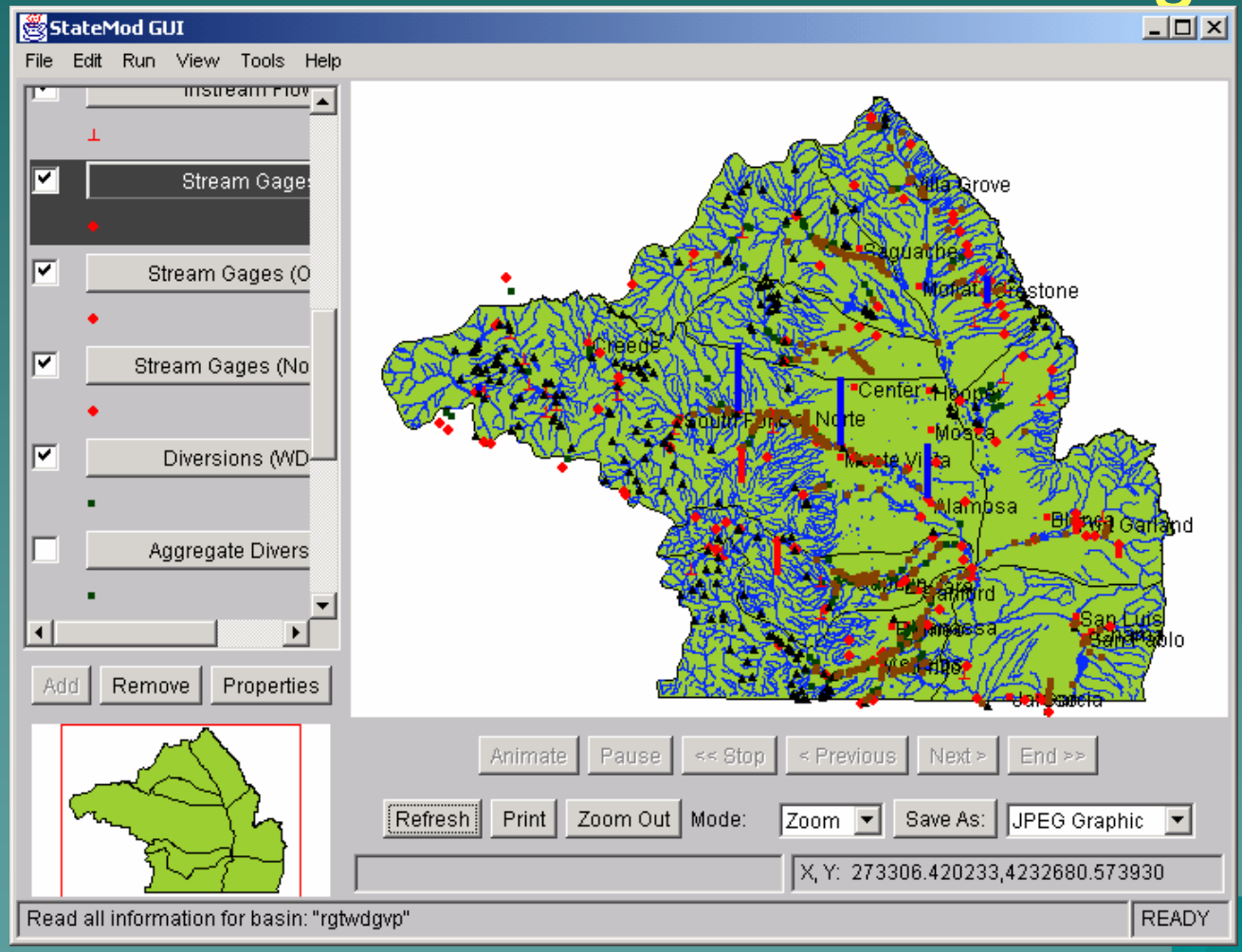


StateCU Typical Results

CU by Water Supply (SW and GW)



StateMod
Colorado's Water Resources Planning Model



Ray Bennett, Colorado Division of Water Resources

StateMod Major Features

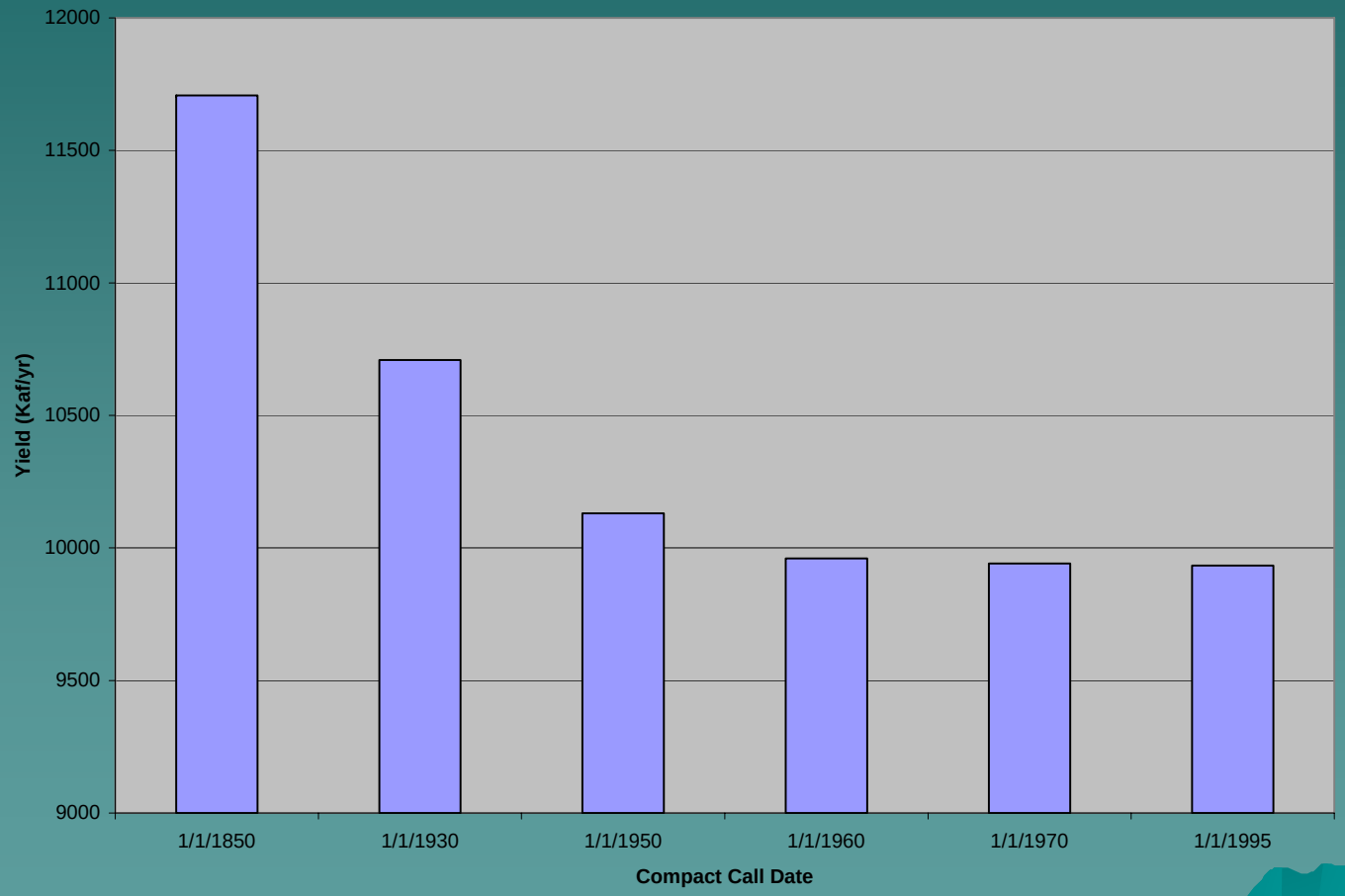
- Network System
- Monthly or Daily Time Step
- Prior Appropriation Doctrine
- Structure Types
  Diversions, Reservoirs, Instream Flows, Wells & Plans
- **Operational Rules**
  - Complex water operations
- Graphical User Interface

StateMod Features (cont.....)

- Creates Base or Natural Flows
- Efficient Solution Method
  - Direct Solution Algorithm
  - Modified Direct Solution Algorithm
- Variable Efficiency
- Soil Moisture Accounting
- Plan Accounting
- Call Reporting

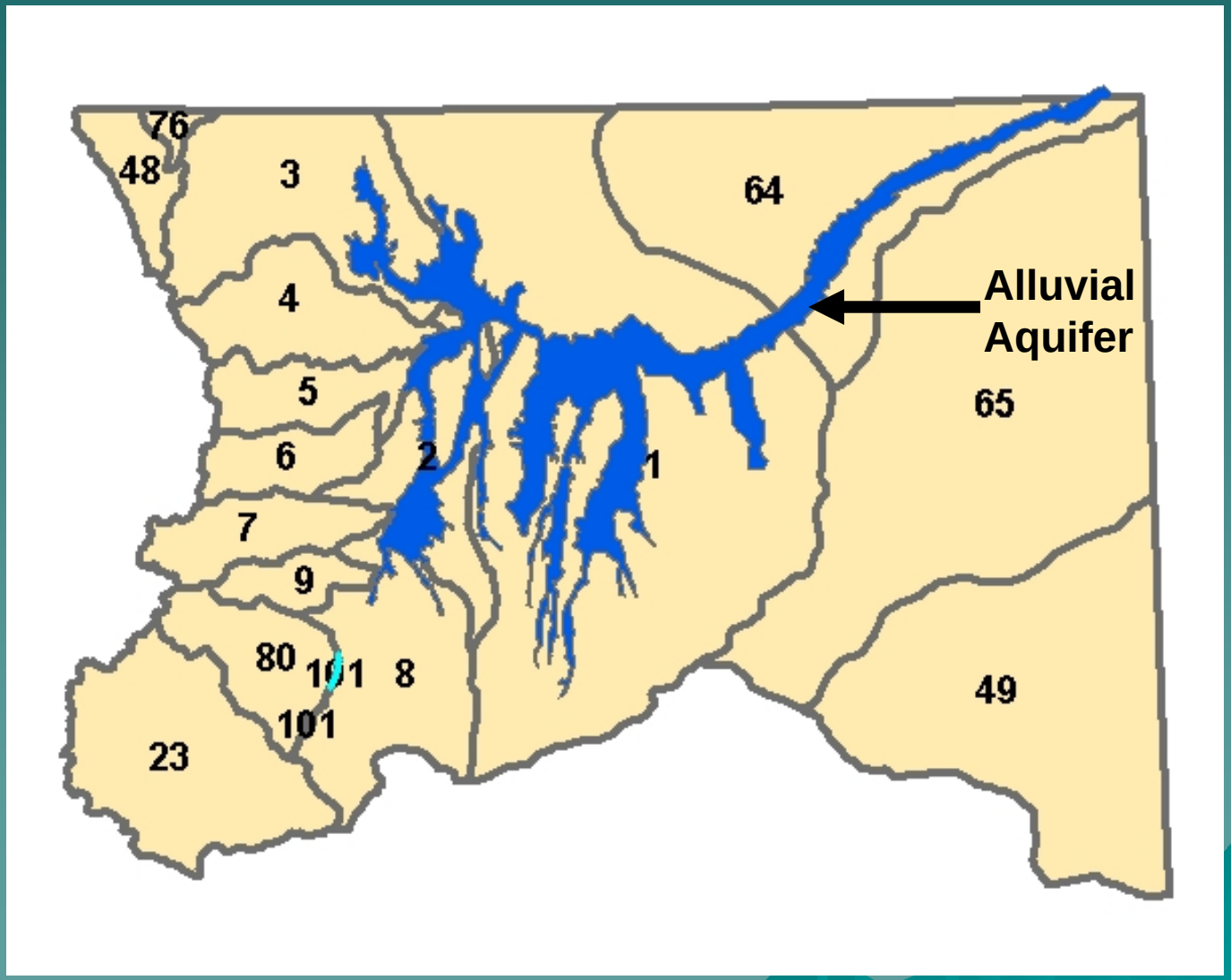
StateMod Typical Results

Compact Delivery Vs Compact Call



Colorado's Ground Water Model

Modflow (USGS)

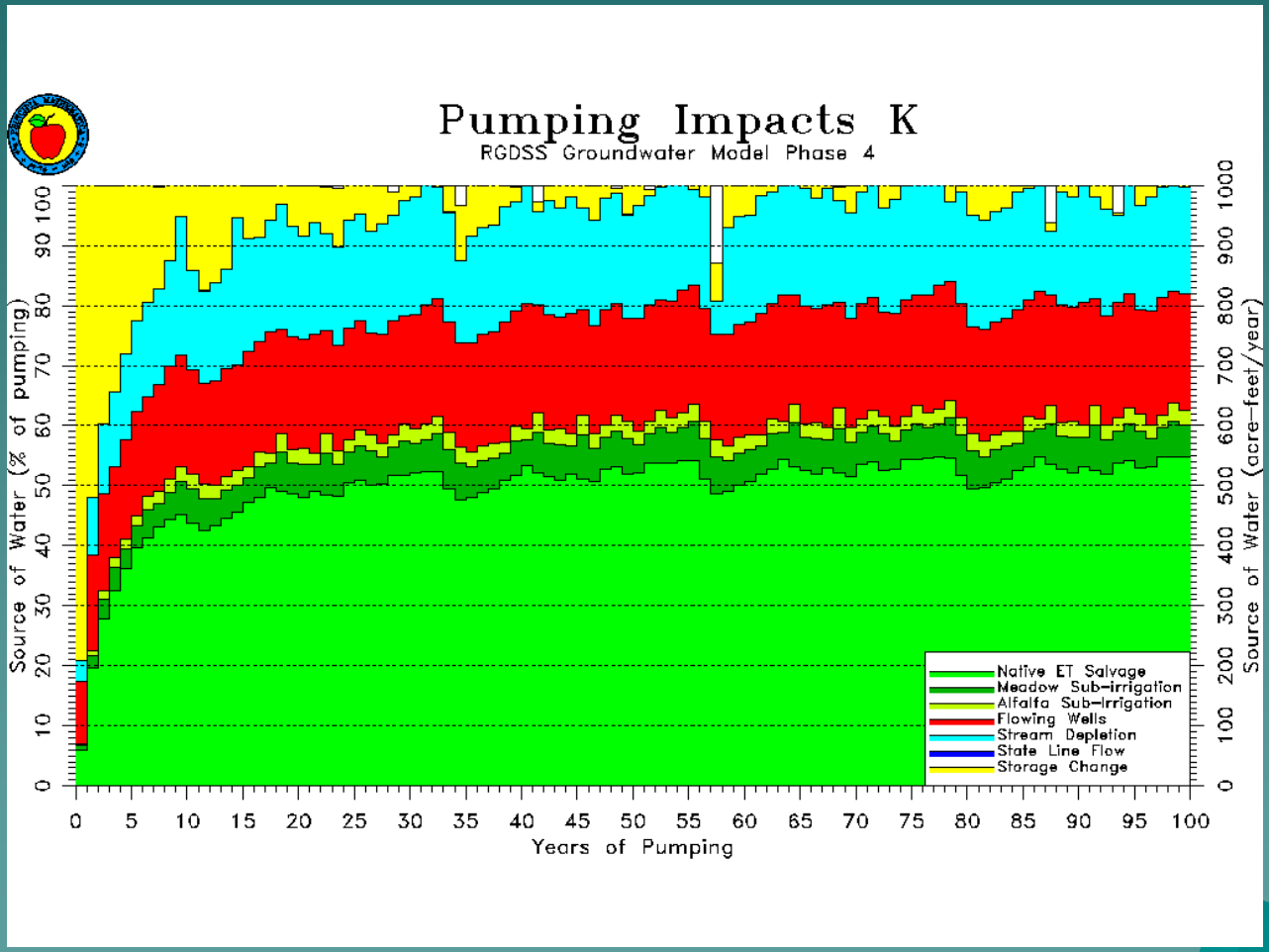


Modflow Features

- Geology
- Aquifer Parameters
- Pumping
- Recharge
- Boundary Conditions
- Streamflows and Diversions
- Springs
- Drains
- Evapotranspiration
- Subirrigation

Modflow Typical Results

Proposed Pumping Impact



More about SPDSS

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  - http://cdss.state.co.us
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